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Muskeg River
Interim Management Framework for Water Quantity and Quality

Summary Report

Management Guidance for Aquatic Components of the Muskeg River Watershed

June 2008

Alberta
ENVIRONMENT

Muskeg River Interim Management Framework for Water Quantity and Quality Summary Report

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1 INTRODUCTION

The Muskeg River watershed is located in the Athabasca Oil Sands region of northern Alberta, within the Regional Municipality of Wood Buffalo. The river is a tributary to the Athabasca River and drains an extensive area of boreal forest wetlands. The mouth of the river is located about 55 km north of Fort McMurray and about 5 km east of Fort MacKay. The area of the Muskeg River watershed is about 1,480 km^2. There are several major tributaries to the Muskeg River, including Jackpine, Muskeg and Wapasu creeks. Kearl Lake is the largest lake within the watershed. It is 5.6 km^2 in size, and drains an area of 85.6 km^2. Figure 1.1 shows the location and extent of the watershed.

The Muskeg River watershed is located within the boreal forest. Its lowlands are covered with black spruce and tamarack muskeg, while the upland areas are treed with trembling aspen, white spruce and jackpine forests. The Muskeg River is a brown water system. Beaver ponds are common throughout the watershed, which influence both streamflow and water quality. The river provides important fish habitat, with white sucker, longnose sucker, lake chub and Arctic grayling the most common species.

The Muskeg River watershed is underlain by mineable oil sands which are of increasing economic importance to Alberta. Currently, two producing oil sands mines and one limestone quarry operate within the watershed. Several other oil sands projects have recently been approved, but not yet developed. Table 1.1 lists the existing, approved and planned oil sand projects in the Muskeg River watershed.

These mining activities have the potential to disturb about 50 to 60% of the Muskeg River watershed area. Without careful planning and appropriate regulations, there are concerns that the cumulative effects of these large-scale and long-term developments could compromise the ecological integrity of the area.

Ecological Integrity can mean different things to different people. One definition states that it is the degree to which the physical, chemical and biological components of an ecosystem (including their composition, structure and processes) and their relationships are present, functioning and self-sustainable. It is a measure of the ability of an ecosystem to support and maintain a balanced, adaptive system with a species composition, diversity and functional organization that is comparable to that of natural systems.

It is therefore necessary to develop a strategy to appropriately manage the resources within the Muskeg River watershed to prevent impacts on its ecological integrity. Cumulative effects management, integrated regional planning and comprehensive watershed management are ways in which environmental impacts of development can be minimized.

Using these approaches, Alberta Environment (AENV) has developed the Muskeg River Interim Management Framework (IMF). The IMF describes a management approach for water resources (water quantity and water quality) in the Muskeg watershed. The IMF will be used as a temporary 'backstop' to manage development and guide regulatory decisions in the Muskeg River watershed until the end of 2009. AENV, in collaboration with First Nations and other stakeholder, will immediately initiate the comprehensive plan for the Muskeg River watershed and will target to complete by the end of 2009. If the comprehensive plan is not completed by the end of 2009, AENV will consider updating and revising the Interim Framework.

Table 1.1 Major Existing, Approved and Planned Development Projects in the Muskeg River Watershed

Company\Project Name	Status	Approval Date	Capacity	Land Disturbance (ha)[g]
Albian Oil Sands Muskeg River Mine	Existing/ Approved	1999	150,000 [a]	4,383
Albian Oil Sands Muskeg River Mine Expansion	Approved	2006	120,000 [a]	8,091
Shell Canada Limited Jackpine Mine – Phase 1	Approved	2004	200,000 [a]	8,154
Shell Canada Limited Jackpine Mine Expansion	Planned	2007 [e]	100,000 [a]	13,030
Imperial Oil Resources Kearl Oil Sands	Approved	2007	200,000 [a]	19,660
Syncrude Canada Aurora North	Existing/ Approved	1997 [f]	195,000 [a]	7,980
Syncrude Canada Aurora South	Approved	1997 [f]	195,000 [a]	8,966
Husky Energy [c] Sunrise Thermal Project	Approved	2007	200,000 [a]	534
Birch Mountain Resources [d] Muskeg Valley Quarry	Existing/ Approved	2005	6,900,000 [b]	1,500
Birch Mountain Resources Hammerstone Project	Planned	2006 [e]	24,400,000 [b]	

a barrels of bitumen production per day (bbl/d).
b tones of limestone per year.
c Husky Sunrise is an situ recovery project that will use Steam Assisted Gravity Drainage (SAGD). All other oil sands projects in the watershed are open pit truck and shovel mining.
d Birch Mountain Resources received regulatory approval for its Muskeg Valley Quarry in 2005 and has recently filed an application for the Hammerstone project which includes a limestone processing facility.
e Application filed date.
f ERCB approval date.
g 1 km^2 = 100 ha

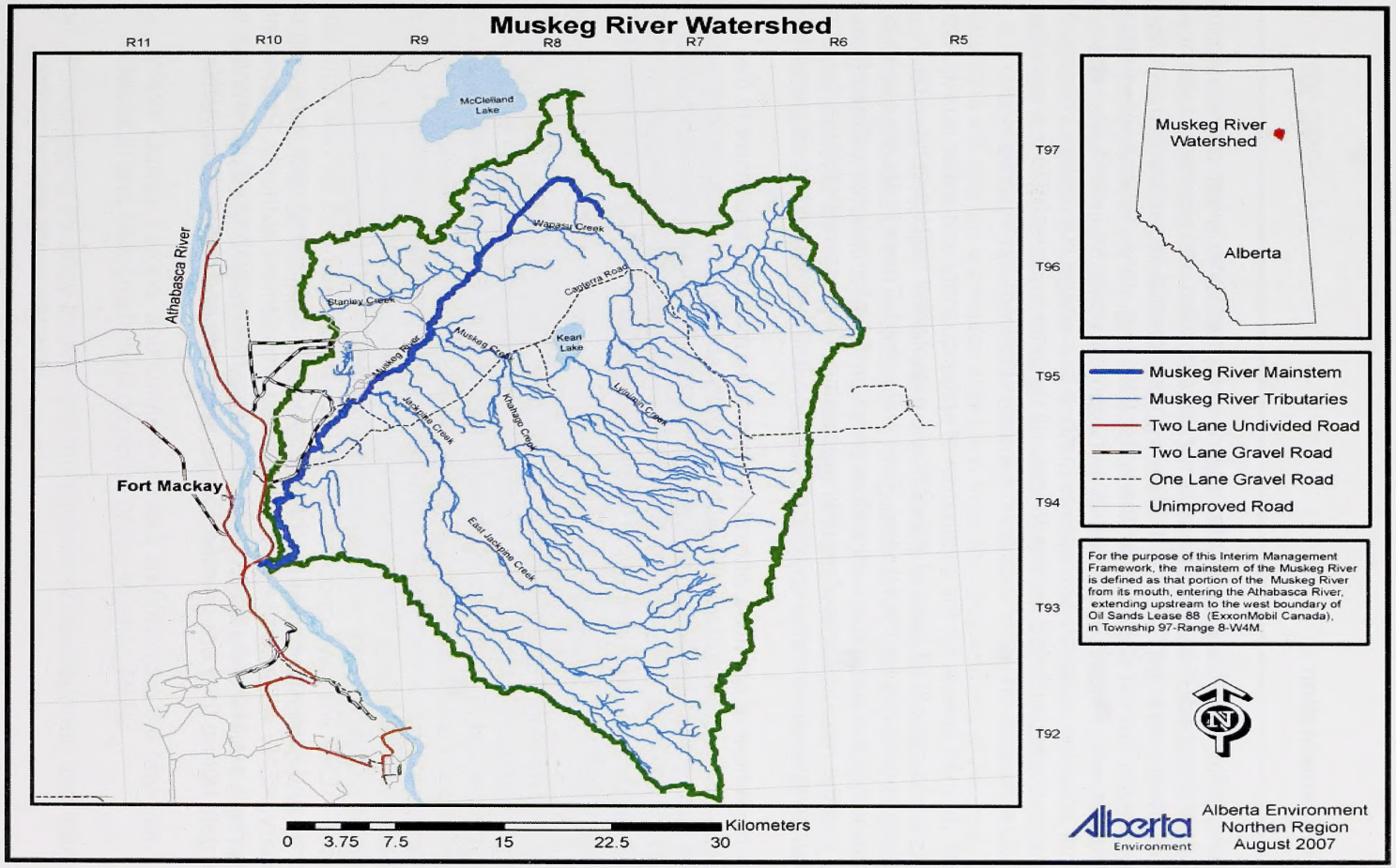

Figure 1.1 The Muskeg River Watershed

1.1 Implementation

The Muskeg River IMF is a structured approach to managing water quantity and quality within the watershed. It attempts to balance development with environmental needs. It takes an integrated approach to cumulative environmental impacts and managing multiple environmental stressors on the watershed (e.g., land disturbance, discharges to the environment). Establishing isolated management goals for individual companies or industrial activities is not an appropriate method to manage cumulative impacts. The IMF is an outcome-oriented approach that will be more successful to manage the cumulative impacts on water quality and water quantity in the Muskeg River.

The IMF defines criteria for the evaluation of water quantity and water quality. Observed conditions are compared against scientifically-established limits that have been developed specifically for the Muskeg River watershed. These limits are based on data collected within the watershed, as well as more broad information on streamflow, water quality and the requirements of aquatic organisms. This approach follows the principle of maintaining environmental conditions as close to the natural state as possible.

The management of activities within the watershed must be responsive to the evaluation process. Therefore, the water quantity and quality limits established in the IMF are associated with management actions. Compliance with the appropriate management actions will offset environmental impacts, reducing stresses on the ecosystem. Ongoing monitoring and follow up is required, including adjustments to the IMF as necessary.

The IMF will meet its management objectives by working within the existing legal and regulatory framework. Water quality and water quantity are regulated respectively under the *Environmental Protection and Enhancement Act* (EPEA) and the *Water Act*, which are administered by AENV. The IMF will be largely implemented through the terms and conditions in the EPEA and *Water Act* licenses and approvals issued for development projects in the watershed. These Acts allow AENV to establish limits, targets and management objectives for water quality and water quantity to protect aquatic resources. AENV will have opportunities to impose requirements for new applications of approvals and licenses, as well as through renewals and amendment applications. If necessary, AENV will also use Director-initiated amendment authority. Proponents of development projects may be required to demonstrate how they will meet these limits and targets before they are granted license approvals and renewals by AENV.

2 SCOPE

The purpose of the IMF is to guide AENV's regulatory decision making within the Muskeg River watershed. The IMF focuses on water quality and quantity for two reasons. First, AENV and Fisheries and Oceans Canada (DFO) jointly released a water management framework for the lower Athabasca River, making the management of regional tributaries (including the Muskeg River) a priority. Alberta Environment has a regulatory and legislative mandate under the *Environmental Protection and Enhancement Act* (EPEA) to manage all aspects of environmental quality and under the *Water Act* to specifically manage water quantity. However, many terrestrial and wildlife considerations will require a broader approach from the Government of Alberta.

Second, the basis of the IMF is that the water quantity and water quality of the Muskeg River are driving forces of the watershed. Changes to water quantity and water quality have ecosystem-level ramifications, including impacts on habitat and aquatic and terrestrial populations. By appropriately managing and protecting water quantity and quality, the structure and function of the aquatic ecosystem as a whole should remain intact.

Water Quantity: The physical characteristics of water flow, including its volume and timing. Appropriate management of water quantity can ensure suitable water quality (through sufficient dilution) and habitat for aquatic organisms.

Water Quality: The mass load and concentration of chemical constituents in the water, both suspended and dissolved. Appropriate management of water quality ensures protection of aquatic habitat and other uses (drinking, recreation, industry etc.).

Aquatic Health: The general status of aquatic organisms. This can be measured through population level characteristics such as density, diversity, recruitment (birth/colonization, immigration rates) and mortality. Aquatic health is more difficult to monitor and assess than water quantity and quality, but provides a litmus test for how well quantity and quality are being managed.

The specific objectives of the Interim Management Framework were to develop:

- Water Quantity Objectives for the Muskeg River and Kearl Lake that protect water quality, aquatic habitat and organisms
- Water Quality Targets and Limits to protect and maintain the physical, chemical and biological characteristics of the Muskeg River
- A monitoring strategy to evaluate the impacts of development and manage and/or reduce those impacts

- An approach and information system that will assist the development of the Muskeg River Water Management Plan

A **Water Quantity Objective** is the amount of water (flow in rivers, level in lakes) required to protect water uses. These limits are defined in order to maintain the natural range of flows required for aquatic organisms, aquatic or riparian habitat, water quality and the physical geomorphic processes of the aquatic system. Objectives are site-specific and based on local characteristics and the natural seasonal variation of the water body.

A **Water Quality Target** is a point where a non-desirable shift in a water quality parameter has occurred. These are established using an "anti-degradation" (or keep water clean) approach. Targets are set for individual water quality parameters and can be established for various scenarios and environmental conditions, such as seasons, developmental stages of organisms, or climate change. By preventing a water quality parameter from exceeding its target, water quality can be maintained with no significant degradation.

A **Water Quality Limit** is a point beyond which a designated water use may be impaired. These are established under a "use-protection" perspective, using water quality guidelines. By preventing a water quality parameter from exceeding its capacity limit, impacts on water uses may be prevented.

Water quantity and quality objectives and targets are good surrogates for monitoring ecosystem health and for identifying changes to other ecosystem components. Alberta Environment recognizes that this is not a complete approach. A comprehensive approach would also include aquatic organisms. However, organism responses to development can be difficult to interpret. A comprehensive monitoring and management plan will address impacts on aquatic communities. Meanwhile, AENV has provided the best available approach that can be managed with certainty in time and location.

3 APPROACH

Alberta Environment has recently adopted a new approach to address cumulative effects on the environment. This approach attempts to balance economic growth with environmental protection of air, water, land and biodiversity. The purpose of this new approach is to guide environmentally responsible development by establishing socially acceptable, economically feasible and environmentally sustainable limits, targets and outcomes. These management actions are then incorporated into the regulatory process. The new approach represents a shift from the traditional 'project-based' environmental protection to a holistic and collaborative management perspective.

The IMF is an important first step toward addressing the cumulative effects of development on the Muskeg River watershed. The IMF establishes limits and targets for water quality and water quantity pending the development of an integrated management plan for the entire watershed. The interim water quality and water quantity limits and targets could be revised in the future under consideration of social and economic values and interests of local communities and stakeholders.

3.1 Baseline Data Review

There is a significant amount of existing baseline information and data for the Muskeg River watershed. This is primarily available through recent oil sands project EIAs and monitoring reports, through AENV at its long-term river monitoring stations, and through the Regional Aquatics Monitoring Program (RAMP). An extensive volume of information has also been gathered by the Cumulative Environmental Management Association (CEMA) and will be used to support the development of the long-term Muskeg River Water Management Plan. This available information was consolidated and used to develop the IMF.

3.2 Establishing Thresholds and Management Conditions

The IMF is based on a combination of anti-degradation and effects-based limits. The Water Quantity Objectives and Water Quality Targets and Limits are derived from a scientific understanding of aquatic ecosystems and their capacity to tolerate disturbance and assimilate external stressors. Water quality and quantity monitoring data collected along the Muskeg River will be used as indicators of the effects of development in the watershed as a whole and are considered surrogates for ecosystem health.

In setting Water Quantity Objectives and Water Quality Targets and Limits for the Muskeg River, the IMF has used existing information on streamflow, water quality and biotic requirements. From these data, minimum water quantity and quality thresholds were established. These thresholds are associated with management actions to offset the human and industrial impacts on water use. Figure 3.1 shows the scale of responses and management actions, depending on the current environmental conditions in relation to the established thresholds.

The Water Quantity Objectives translate into combinations of river flow (quantity of water in the river) and discharge limits to maintain water quality. Water Quality Targets and Limits have been defined from a "keep water clean" perspective and a "use-protection" perspective, respectively.

The IMF consists of three environmental management conditions for both water quantity and quality. These conditions correspond to environmental changes as streamflow and/or water quality decline. The three environmental management conditions are colour coded as:

- **Green:** Cumulative impacts from development on flows and water quality have no measurable negative impact on management goals for ecosystem integrity; the aquatic system is in near-background state. No management actions or responses are required.
- **Yellow:** Negative impacts to the aquatic system are resulting in its shift away from the management goals for ecosystem integrity. As a result, sources of these impacts, as well as trends and risks must be evaluated. Management activities are invoked where possible. Enhanced monitoring and risk management plans are required and shared management activities to improve conditions are promoted.
- **Red:** Impacts to the aquatic system exceed limits for ecosystem integrity, and require a management response. Red conditions (low flow based) for water quantity require mandatory adherence to cumulative loss limits. The exceedance of Water Quality Limits for a certain parameter requires mandatory reductions in that parameter load.

3.3 Consultation and Review

During the planning process for the IMF, AENV consulted with key stakeholders from local First Nations, the oil and gas industry, environmental groups and other regulatory agencies. Alberta Environment also consulted with other key stakeholders that express interest in being part of the consultation process.

Alberta Environment engaged in consultation with the Athabasca Tribal Council (ATC) and their designated directors from the Industry Relations Corporation (IRC), in order to fulfill Alberta's duty to consult with First Nations on initiatives that have the potential to impact lands protected by Treaty Agreements. Five consultation sessions with the First Nations were hosted by AENV between June 2007 to March 2008. In each session, First Nations' input and suggestions were collected. During this process, Aboriginal communities had the opportunity to improve their understanding of key issues and provide input regarding preferred options and solutions.

Once complete, the draft Muskeg River IMF was made available to the affected industry, government regulatory departments, First Nations' IRCs and other interested groups for feedback. Overall, there was substantial support for the draft IMF, indicating that was a good start to the management of water quality and quantity, in the absence of a comprehensive management plan. However, industry representatives were concerned that the document was biased toward conservation and will limit both approved and future oil sands developments. Other stakeholders noted that protecting water quantity and water quality alone does little to address land-based components, as well as social and cultural concerns.

Despite the challenges associated with accommodating such diverse interests, AENV has incorporated these opinions as much as possible into the final document. Alberta Environment values the comments and concerns of all the stakeholders and is committed to achieve a balance between oil sands development and the protection of environmental values in the Muskeg River watershed.

Water quality is managed based on many chemical parameters in the water while quantity is managed based on flow expectations for each week. Individual investigation and water quality objective triggers exist for each parameter that enters the river (e.g. nutrients, metals and industrial chemicals) with management actions for these triggers as shown in the figure below.

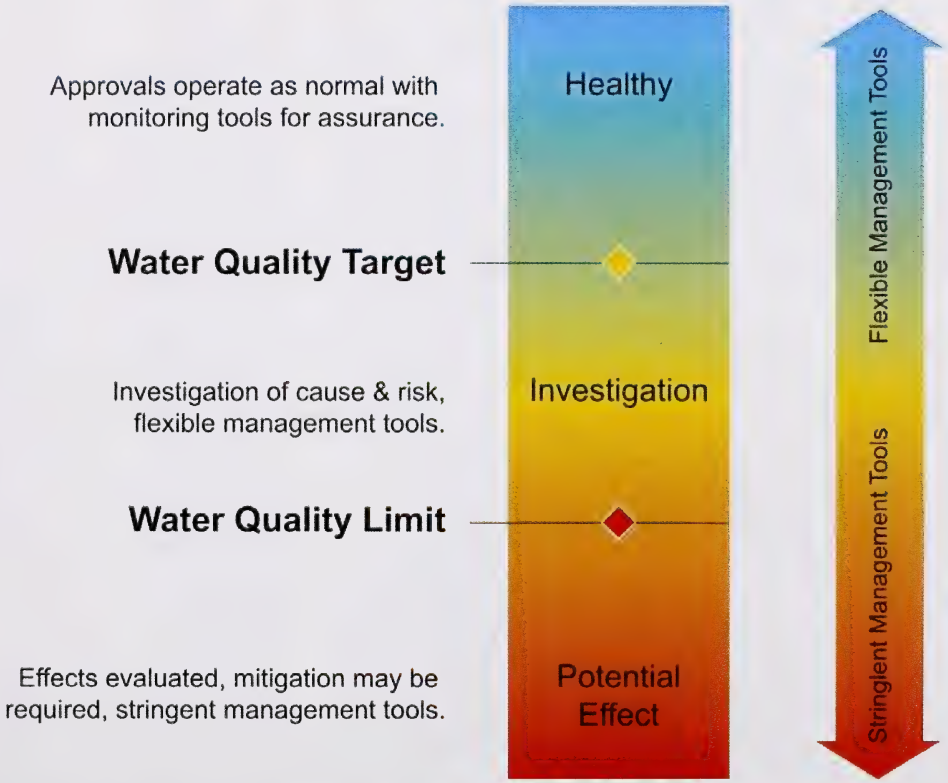
Approvals operate as normal with monitoring tools for assurance.
Healthy
Water Quality Target
Investigation of cause & risk, flexible management tools.
Investigation
Water Quality Limit
Effects evaluated, mitigation may be required, stringent management tools.
Potential Effect
Flexible Management Tools
Stringent Management Tools

Figure 3.1 Scale of Responses to Environmental Management Conditions

4 RESULTS AND ANALYSIS

4.1 Water Quantity Objectives

The Water Quantity Objectives translate into combinations of river flow (quantity of water in the river) and discharge limits for the maintenance of water quality. A minimum of 85% of instantaneous flow is required to support aquatic life under most flow conditions (15% is allowed for use). These are designated as green conditions. Increasing restrictions are required during dry periods, which are designated as yellow or red conditions, depending on the degree of low flow conditions. The yellow threshold is approximated by the Q80 streamflow, while the red threshold is approximated by the Q95 streamflow.

Q80: A naturally low streamflow where 80% of observed flows are greater than this value. The value is similar to the 20th Percentile.

Q95: A naturally very low streamflow where 95% of observed flows are greater than this value. The value is similar to the 5th Percentile.

Mean: The average value in a group of numbers. It is the sum of all the values in that group divided by the number of values.

Median: The middle value in a group of numbers that are sorted in ascending or descending order. Half the numbers in this group are above the median value and half are below the median value.

The objectives were designed to follow the natural streamflow changes seen over time. The normal flow regime of the Muskeg River is shown in Figure 4.1.

4.1.1 Goals and Objectives for the Muskeg River

The water quantity goals for the Muskeg River are:

- Maintain open water flow conditions such that the quality of aquatic habitat remains unchanged or improves
- Maintain an appropriate frequency of high flow events to maintain or improve aquatic habitat

- Maintain wet and dry conditions on river edge for riparian, fish spawning and invertebrate considerations
- Maintain sufficient water to ensure maintenance of water quality thresholds
- Ensure no physical diversion or re-routing of the mainstem of the Muskeg River while the IMF is in place

The Water Quantity Objectives and associated management actions are:

- **Green:** Only 15% of the instantaneous flow is available for consumptive use in any week, should withdrawals occur. If watershed modifications result in increases in flow, the increases for the mean, median and peak flow statistics are expected to remain within 15% during the open water season. Winter increases in flow must not increase the variability of flow and must conform with the maintenance of water quality objectives.
- **Yellow:** Only 5% of flow is available for consumptive use, should withdrawals occur. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in yellow conditions.
- **Red:** No water is available for consumptive use or other withdrawals. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in red conditions.

4.1.2 Objectives for Kearl Lake

Kearl Lake has a relatively large surface area but relatively small water volume and low mean depth. The Water Level Objectives for Kearl Lake are to maintain historic water levels, with management favouring a slight increase over a decrease. Objectives were based on a water balance model presented in Imperial Oil's Kearl Oil Sands Project EIA. The 10^{th} percentile low water level was chosen as a minimum, the long-term average as the management target and the 99.91 percentile as the maximum objective. Water levels in Kearl Lake will be managed to the target water level, which may fluctuate within reasonable frequency between the minimum and maximum water levels.

The Water Level Objectives for Kearl Lake are:

- Target water level: 331.94 metres above sea level (masl)
- Minimum water level: 331.71 masl
- Maximum water level: 332.29 masl

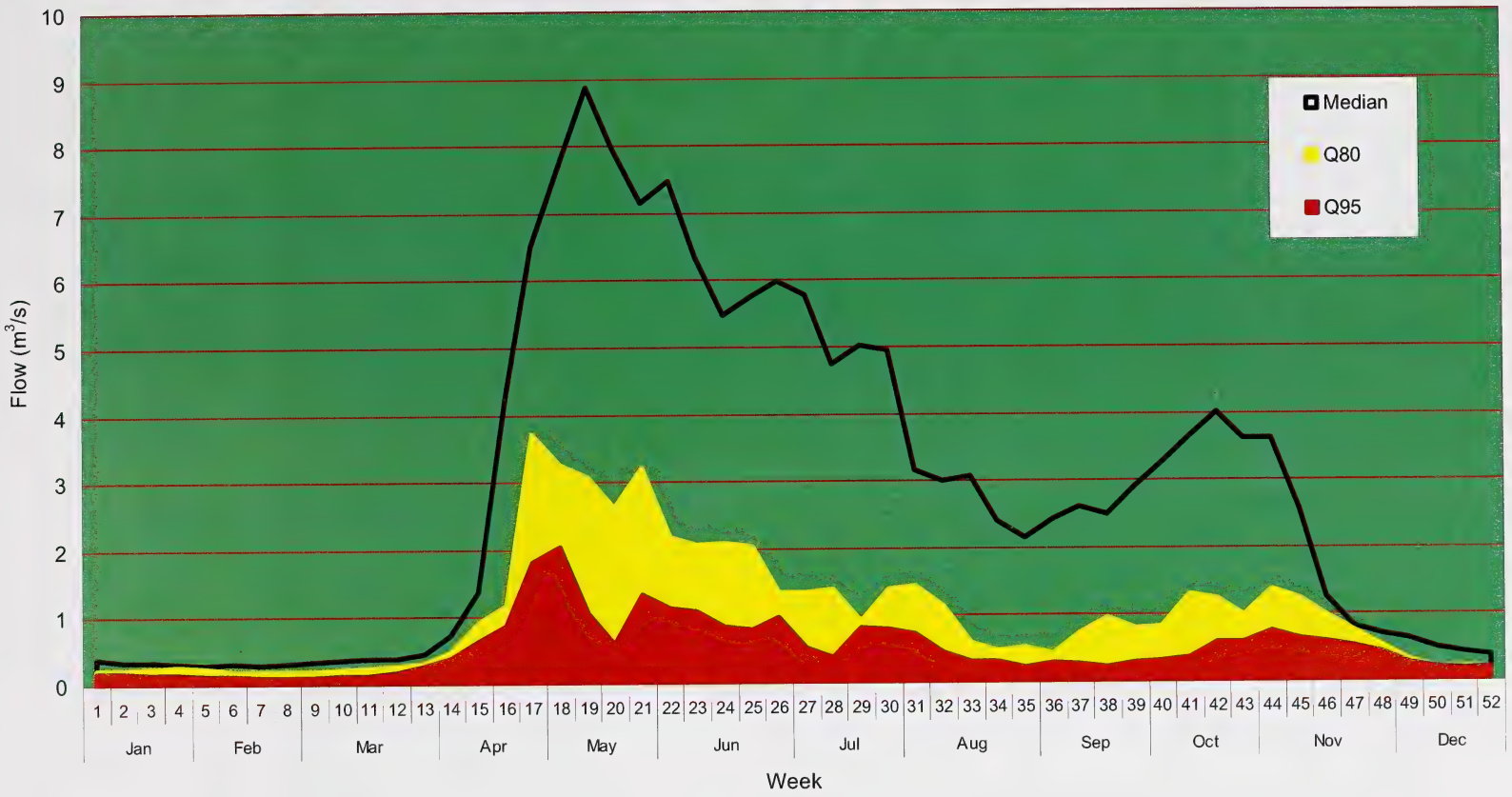

Figure 4.1 Natural Flows and Environmental Management Conditions of the Muskeg River

4.2 Water Quality Targets and Limits

Water Quality Targets and Limits for the Muskeg River were established via the following:

- **Water Quality Targets (WQTs):** established through the use of background concentrations, following an anti-degradation approach
- **Water Quality Limits (WQLs):** established through the adoption of existing water quality guidelines, following a use-protection approach

Keep water clean (anti-degradation) targets, or Water Quality Targets (WQTs), were based on that point at which contaminants increase in the river by more than 20% of the mean and peak values. Use-protection limits, or Water Quality Limits (WQLs) were based on existing Alberta, Canada and United States water quality guidelines. Tools used in the Interim Management Framework define how much more loading is acceptable to ensure that the Water Quality Targets and Limits are not exceeded.

Targets and Limits were established for both chronic (mean) and acute (peak) conditions. Each water quality parameter therefore has as many as four thresholds: a chronic and acute threshold for both the yellow and the red conditions. The yellow WQTs instigate an investigative action and are meant to guide management actions for evaluation and improvement where possible. In comparison, the red WQLs are represent potential effects levels. Management actions are stringent and mandatory under red WQL conditions. Appropriate mitigation is required if WQLs are exceeded.

Water Quality Guideline: A numerical concentration or narrative statement recommended to support and maintain a designated water use. Designated water uses include protection of aquatic life, source water for drinking water, recreation, irrigation, industrial and aesthetics.

Acute Toxicity: Adverse effects on the survival of an organism that occur within a short time following exposure to a chemical.

Chronic Toxicity: Adverse effects on an organism that occur over the long term following exposure to a chemical. Behaviour, growth and reproduction of the organism may be affected.

4.2.1 Parameter Selection

The first step in determining Water Quality Targets and Limits was to select parameters that are sensitive to environmental change within the watershed. These parameters must also be manageable. The parameters were chosen using the following criteria:

- Loadings of the parameter could occur due to development activities
- The concentration of the parameter in the potential sources is at least two times greater than background concentration
- The parameter is consistently detected in potential source waters when more than 50% of the background concentrations of the parameter are non-detectable

The parameters were selected from monitoring data collected for about 100 key water quality compounds. These parameters include metals, toxic organic compounds, and non-toxic but ecosystem altering nutrients. Water quality parameters that are predicted to be released into the river as a result of development in the Muskeg River watershed were automatically considered and screened as above. As new parameters are identified (for example, from future monitoring or modelling results), they will be assessed in the same way. The IMF will be amended to include them, as necessary.

4.2.2 Goals and Objectives

Background concentrations of the selected water quality parameters were determined from existing monitoring data collected in the Muskeg River. Computer models were calibrated to these background concentrations and then used to develop the yellow WQTs and red WQLs for each selected parameter. Table 4.1 lists the chosen parameters and their respective targets and limits.

The intent of the yellow WQT condition is to protect existing uses and maintain near-pristine water quality. WQTs were defined based on historic water quality data collected from within the Muskeg River watershed, which represent background conditions. An increase of more than 20% of mean and peak background concentrations for pollutants was considered to approach changes in the Muskeg River that exceed anti-degradation expectations.

Effects-based criteria were the basis for defining the red management zone, or WQLs. In general, existing Alberta, Canada and international water quality guidelines for the protection of aquatic life were used to establish the WQLs.

A yellow Water Quality Target (WQT) and a red Water Quality Limit (WQL) were defined for each selected water quality parameter for both chronic (mean) and acute (peak) conditions.

The management actions under the three water quality conditions are:

- **Green:** During green conditions, impacts on water quality are minimal and no management actions or responses are required.
- **Yellow:** During yellow conditions, impacts on water quality are likely, such that anti-degradation limits are exceeded. These conditions instigate an investigative action and are meant to guide management actions for evaluation and improvement where possible. Monitoring and risk management plans are required to improve water quality.
- **Red:** During red conditions, water quality impacts are high enough that not all uses are protected, and are considered to represent potential effects levels. Management actions are stringent and mandatory, including reductions in loading for the parameter or parameters that exceed the red conditions. Monitoring, risk management and mitigation plans are also required to improve water quality.

Table 4.1 Water Quality Targets and Limits for the Muskeg River

Water Quality Parameter	Units	WQT Mean Target (Yellow)	WQT Peak Target (Yellow)	WQL Mean Limit (Red)	WQL Peak Limit (Red)
General Chemistry and Nutrients					
Temperature	°C	10.6	25.3	RSWQO	RSWQO
Chlorophyll a	mg/m^3	5	12	NA	NA
Total Kjeldahl Nitrogen	mg/L	1.300	3.500	RSWQO	NA
Nitrate + Nitrite	mg/L	0.030	0.362	RSWQO	29
Ammonia	mg/L	0.179	0.718	0.5	2.4
Total Phosphorus	mg/L	0.042	0.219	0.05 (RSWQO)	NA
Dissolved Organic Carbon	mg/L	25.6	63.1	NA	NA
True Colour	TCU	63	115	NA	NA
Total Alkalinity ($CaCO_3$)	mg/L	225.3	398.1	NA	NA
Chloride	mg/L	5.4	34.1	230	250
Sulphate	mg/L	11.4	106.5	500	500
Specific Conductance (field)	µS/cm	381	806	NA	NA
Conductivity (lab)	µS/cm	418	799	NA	NA
pH (field)	pH units	6.5, 9.2	6.0, 10.8	6.5	RSWQO
Biochemical Oxygen Demand	mg/L	1.4	2.4	Based on DO	
Chemical Oxygen Demand	mg/L	75.6	221.3	Based on DO	
Dissolved Oxygen (meter)	mg/L	Saturation	1.44^m	6.5*	5*
Total Suspended Solids	mg/L	6.5	82.2	NA	NA
Turbidity	NTU	9	77	NA	NA
Oil and Grease	mg/L	1.09	4.17		
Metals					
Aluminum (total)	mg/L	0.061	0.162	ASWQG variable	RSWQO
Arsenic (total)	mg/L	0.0004	0.0009	RSWQO	0.005
Boron (total)	mg/L	0.05	0.07	0.055	0.2
Barium (total)	mg/L	0.084	0.138	0.088 (RSWQO)	NG
Cadmium (total)	mg/L	ID	0.00003	ASWQG variable	0.0011
Chromium (total)	mg/L	0.0007	0.0034	0.008	0.0083
Copper (total)	mg/L	0.0005	0.0008	0.007	0.17
Iron (total)	mg/L	1.0218	2.6364	NG	RSWQO
Mercury (total)	µg/L	ID	90%<MDL	0.005	0.013

Table 4.1 Water Quality Targets and Limits for the Muskeg River Cont.

Water Quality Parameter	Units	WQT Mean Target (Yellow)	WQT Peak Target (Yellow)	WQL Mean Limit (Red)	WQL Peak Limit (Red)
Metals Cont.					
Lithium (total)	mg/L	0.0119	0.0154	NG	NG
Manganese (total)	mg/L	0.2359	1.2732	0.39	RSWQO
Molybdenum (total)	mg/L	0.0002	0.0003	0.028	0.73
Nickel (total)	mg/L	0.0006	0.0013	0.0072	0.062
Lead (total)	mg/L	0.0001	0.0001	0.001	0.002
Tin (total)	mg/L	ID	ID	0.0022	0.51
Selenium (total)	mg/L	ID	0.0007	RSWQO	0.001
Strontium (total)	mg/L	0.224	0.260	3.3 (RSWQO)	NG
Vanadium (total)	mg/L	0.004	0.013	0.017	0.16
Zinc (total)	mg/L	0.0004	0.0006	RSWQO	0.03
Organics					
Acenaphthylene	µg/L	80% <MDL	0.042	NA	5.8
Benzo(a)anthracene	µg/L	80% <MDL	0.0036	NA	0.018
Benzo(b,j,k)fluoranthene	µg/L	80% <MDL	0.0108	NA	NG
Benzo(g,h,i)perylene	µg/L	80% <MDL	0.0024	NA	0.0152
Chrysene	µg/L	80% <MDL	0.0048	NA	NG
Dibenz(a,h)anthracene	µg/L	80% <MDL	ID	NA	NG
Fluoranthene	µg/L	80% <MDL	0.0048	NA	0.04
Fluorene	µg/L	80% <MDL	0.0192	NA	3
Indeno(1,2,3-c,d)pyrene	µg/L	80% <MDL	0.0048	NA	NG
Napthalene	µg/L	80% <MDL	1.068	NA	1.1
Phenanthrene	µg/L	80% <MDL	0.0144	NA	0.4
Pyrene	µg/L	80% <MDL	0.0048	NA	0.025

* During open water periods only, m = minimum WQT for entire year recognizing that this occurs only in winter
ASWQG = Alberta Surface Water Quality Guidelines
RSWQO = Reach Specific Water Quality Objective development required
80% <MDL = 80% of values are below the Method Detection Limit
NA = Not Applicable
ID = Insufficient Data
NG = No Guideline, candidate for RSWQO

4.3 Monitoring and Implementation

Another key component in the Muskeg River IMF is to monitor for, and respond to, environmental effects. Monitoring can provide the necessary information for periodic updates of the water quantity and quality limits, where required. An integrated monitoring plan for the Muskeg River watershed will be developed with the regional stakeholders. This monitoring plan will coordinate all off-lease monitoring activities that are currently done by individual companies. This coordination will provide an effective and efficient means to determine the current status of the water quantity and quality of the Muskeg River and its tributaries. It will also help determine the potential sources of impacts on water quantity and quality within the watershed. It will build on, and complement the current RAMP and may include:

- Sampling of key parameters
- Periodic checking and interpretation of results
- Reporting and communication of results by both industry and responsible government organizations
- Additional monitoring as required, such as in the event of accidental spills

Specific management actions are required under the three conditions of the framework (green, yellow and red), as described in the sections above. During green conditions, impacts on the water quantity and quality of the Muskeg River are minimal and no further management actions or responses are required. Only 15% of the instantaneous flow is available for consumptive use in any week, should withdrawals occur.

If environmental conditions in the Muskeg River are found to approach and/or exceed yellow conditions for water quantity or quality, increased monitoring is required. The purpose of this monitoring is to determine if the expected impacts occur. This will allow the investigator to gauge the level of response that is required. Only 5% of flow is available for consumptive use, should withdrawals occur.

Under red conditions for water quantity or quality within the Muskeg River, management actions are stringent and mandatory. These include reductions in water quality loading. Monitoring, risk management and mitigation plans are also required to improve water quality. No water is available for consumptive use or other withdrawals.

5 RECOMMENDATIONS

The Muskeg River IMF makes several management recommendations, including:

- Ensure that there is no physical diversion or re-routing of the mainstem of the Muskeg River would occur by end of 2009. However, AENV acknowledges that very late in the process of developing this interim framework, Shell Canada submitted an application for approval of the Jackpine Mine Expansion. This application includes a proposal to mine the upper reaches of the mainstem of the Muskeg River. The interim framework has not attempted to deal directly with this proposal at this time. AENV recommends that the decision on this application be guided by the public interest, considering economic, social and environmental values.
- The Water Quantity Objectives and Water Quality Targets and Limits should be implemented immediately within the Muskeg River
- AENV will take a direct leadership role and will make it a priority to ensure that the long-term Muskeg River Water Management Plan is completed in a timely manner
- AENV acknowledges that First Nations' participation in the long term Muskeg River Water Management Plan is essential. Alberta Environment will ensure that First Nations' input and perspectives are included in the planning process.

6 NEXT STEPS

It is acknowledged that the Muskeg River IMF is focused on environmental outcomes and does not address the broader spectrum of social, cultural and economic values of the watershed. The need still exists for a comprehensive framework that balances economic development, social well-being and a sustainable environment. The IMF therefore sets the stage and establishes a path forward to complete the comprehensive Muskeg River Water Management Plan. The comprehensive Water Management Plan should be developed under the following recommendations:

1. **Collaborative Effort:** AENV recommends a cooperative effort between regulatory departments, industry, First Nations and environmental groups to develop the recommendations for a comprehensive management plan. A holistic approach is required that focuses on watershed management outcomes, building from water quantity and water quality objectives and targets for Muskeg River and Kearl Lake.

2. **Consistent with Provincial Policies:** The comprehensive Water Management Plan should be developed to be consistent with existing provincial policies, including Alberta's Commitment to Sustainable Resource and Environmental Management, Alberta's *Water for Life* Strategy, the Oil Sands: Multi-Stakeholders Consultation report and the Aboriginal Consultation report.

3. **Coordination and Consistency with Regional Management Initiatives:** The Muskeg River watershed is a part of a broader regional system, for which several planning initiatives exist. AENV recommends that the comprehensive Water Management Plan be coordinated and developed to be consistent with regional initiatives and other plans relevant to the watershed.

4. **Legislative Context:** AENV recommends that the comprehensive Water Management Plan should be developed under the guidance and direction of the *Water Act* and the Framework for Shared Governance and Watershed Management Planning, currently under development by the Alberta Water Council (anticipated release date by July 2008).

5. **End to Stalemate:** AENV recommends that an approach is adopted which recognizes that both development and conservation needs to maintain societal benefits and ecological functions in the watershed.

6. **Timelines:** AENV is concerned about the lack of progress on the comprehensive Water Management Plan. AENV recommends that the Water

Management Plan remain a high priority, and all stakeholders should commit to deliver this plan by no later than the end of 2009.

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